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Research Opportunities to Increase Efficiency of Production, Improve Quality, and Expand Utilization of U.S. Peanuts

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RESEARCH OPPORTUNITIES TO INCREASE EFFICIENCY OF PRODUCTION, IMPROVE QUALITY, AND EXPAND UTILIZATION OF U.S. PEANUTS

U.S. DEPARTMENT OF AGRICULTURE
Agricultural Research Service

The primary objective of this Workshop was to identify and describe the opportunities for research to increase the efficiency of production, improve the quality, and expand the utilization of U.S. peanuts. In an endeavor to gain a comprehensive response, participants from all segments of the peanut industry and relevant research were invited, including farmers, shellers/handlers, processors and ARS, State and industry scientists. The Workshop format of panel presentations followed by multidisciplinary team deliberations was designed to provide information on emerging technologies and opportunities or needs pertinent to the subsequent team discussions with the expectation that team recommendations would focus on those aspects having significant impact on the future of the peanut industry. Commendation for the degree and manner in which our objective was met belongs to the chairmen, panelists, recorders and participants, and to the secretaries who prepared the report.

PHILIP A. MILLER,
for the Peanut Workshop
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Workshop Steering Committee

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EXECUTIVE SUMMARY

The United States, though only the third largest producer of peanuts and providing only 10 percent of the world peanut production, is the world's leading exporter of peanuts. Among the cash crops grown in the United States, peanuts rank ninth with a farm value of about $1 billion in 1981.

Peanut production on approximately 1-1/2 million acres is concentrated in three major regions--the Virginia/North Carolina area; the Southeastern States of Georgia, Alabama, and Florida; and the Southwestern States of Texas and Oklahoma. Domestically, peanuts are used primarily for food with peanut butter and edible peanuts accounting for about one-half of the crop and exports accounting for about one-quarter. The remainder is marketed either as seed, as meal and oil (14%), or retained as carryover.

In light of increasing world competition for peanuts and peanut products, increasing production costs, and a plateauing of yield per unit of land, greater cost efficiency in production, sustained quality, and expanded utilization of peanuts are essential for a viable and stable peanut industry. The primary objective of the Workshop was to identify and describe the researchable factors limiting the efficiency of production, quality, and utilization of U.S. produced peanuts. The participants contributed to discussions concerning developing and emerging technologies and opportunities that might have significant impact on the future production, utilization, and marketing of peanuts.

The product of the Workshop consists of a series of major researchable problems which presently limit production efficiency and peanut quality and utilization. The following list, presented by area of interest, enumerates those researchable problems which the Workshop suggests as critical to the future of the U.S. peanut industry. Detailed descriptions of the nature and importance of these and other researchable problems identified by consensus as medium and low priority are presented in the following sections:

1. Peanut Production Efficiency in the Virginia/North Carolina and Southeastern Production Areas.

   - Develop and evaluate peanut germplasm and cultivars superior to existing varieties in disease and insect resistance, drought tolerance, early maturity, yield, and quality.

- Develop improved procedures for soil and water management with emphasis on cost/benefit ratios and protection and conservation of natural resources, especially soil and water resources.

- Develop needed data on crop protection with emphasis on programs that result in cost reductions in peanut production.

2. Peanut Production Efficiency in the Southwestern Production Area.

   - Improve water management and water-use efficiency.

   - Breed peanuts with increased genetic potential for profitable production in the Southwest.

   - Develop integrated systems for managing peanut plant pests.

   - Improve aflatoxin monitoring, prevention, and decontamination techniques.

3. Harvesting, Handling, and Marketing Efficiency.

   - Develop sensors that are compatible with microprocessors and minicomputers for use in controlling harvesting, curing, and drying equipment.

   - Develop a farmer stock peanut grading system that accurately reflects peanut quality.

   - Develop models that can be used to simulate digging, curing, drying, and shelling to maintain or improve quality of peanuts.

   - Develop new uses and markets for peanuts and peanut byproducts.

4. Quality and Marketing Goals.

   - Develop objective test methods to measure quality, including detection of aflatoxin, of farmer's stock and shelled stock peanuts.

   - Eliminate and/or reduce foreign materials in shelled peanuts, possibly at farmer's stock level.

   - Revise grading system from the farmer's stock level on through the marketing chain.

- Develop additional relevant data on specific quality factors, such as maturity, aflatoxin, foreign material, freeze damage, and off-flavors.

- Establish a peanut product market profile for use by the industry.

These researchable problems will be of value as the Agricultural Research Service, the States, and industry continue to define their programs for future peanut research to meet the goal of improving the role of the U.S. peanut industry both domestically and worldwide.

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INTRODUCTION

Problem Statement, Workshop Objectives, and Procedures

The United States is the third largest producer of peanuts, accounting for 10 percent of the world peanut production. Peanuts are the ninth most valuable cash crop grown in the United States. The 1981 crop of almost 4 billion pounds had a farm value of approximately $1 billion. In addition, the United States is the world's leading exporter of peanuts.

Peanuts grown in the United States are used primarily for food. Peanut butter and edible peanuts account for about one-half of the U.S. peanut crop; exports account for about one-quarter of the crop; and the remainder is marketed as meal and oil. The crop is grown on approximately 1-1/2 million acres concentrated in three major production regions--the Virginia/North Carolina area; the Southeastern States of Georgia, Alabama, and Florida; and in Texas and Oklahoma in the Southwest.

The future of the peanut industry depends on maintaining and improving the competitiveness of U.S. produced peanuts in both price and quality with other domestic food alternatives and with peanut production in other countries. Peanut production costs have increased substantially in recent years with the U.S. average cost reaching $720 per acre in 1981. Although average harvested-acre yields have increased almost threefold since 1950, there is some evidence that yields are beginning to level off. Acreage has remained relatively constant since 1950. Thus, increased efficiency of production, sustained quality, and expanded utilization of peanuts are essential for the maintenance of a viable and stable peanut industry.

The primary objective of this Workshop was to identify and describe the researchable factors limiting the efficiency of production and utilization of U.S. peanuts. Workshop participants (see listing in Appendix I) included representatives of producers, shellers/handlers, and processors, in addition to ARS, State, and industry scientists. The first portion of the Workshop (see Workshop Agenda, Appendix II) included special panel presentations and discussions on those developing and emerging technologies and apportunities that might have significant impact on the future production, utilization and marketing of peanuts. During the second portion of

the Workshop, participants formed multidisciplinary teams to identify and describe the major factors limiting the efficiency of production and utilization of peanuts in the following segments of the industry:

- Peanut production efficiency in the Virginia/North Carolina and Southeastern production areas.
- Peanut production efficiency in the Southwestern production area.
- Harvesting, shelling, handling, and marketing efficiency.
- Quality and marketing goals.

U.S. Peanut Industry--Current Situation and Outlook

D. L. Hacklander

Peanut Program Setting

The United States peanut industry is in a stage of transition from an era of restricted production with price supports based on percent of parity to unrestricted production with quota support levels based more on cost of production and additional peanut support levels based on market clearing prices for meal and oil. Currently the support level for quota peanuts is $550 per ton--the minimum set in the 1981 Farm Act--and the level for additionals is $185/ton. In comparison, if support were still based on 75 percent of parity, the support (as of June 1984 parity prices) would be $687/ton.

Why the transition? From 1959 to 1981 peanut acreage allotments were at the legal minimum of 1.61 million acres except for some increases for types of peanuts in short supply, primarily Valencias. Yields increased from 1,100 pounds per acre to 2,695 pounds--nearly two and one-half times. Consequently, production increased from 1.5 billion to nearly 4 billion pounds. Domestic use for food did not keep pace with the production growth. Thus, the Government was accruing more and more peanuts for disposal on the export market or to crush into oil and meal. Both these options were at prices below the support rate, so the cost of the peanut program continued to escalate.

Within this context of high public cost and surplus peanut production, deliberations were made relative to the 1977 farm legislation. The 1977 legislation authorized a two-price poundage quota program with declining minimum quota level from a minimum of 1.68 million tons for 1978 to 1.44 million in 1981. Nevertheless the quota level continued to exceed domestic use.

The Agricultural and Food Act of 1981 continued the two-price poundage quota program and reduced the minimum poundage quota to 1.2 million tons in 1982 to be reduced to 1.1 million in 1985, with the reduction to be shared equally among States. Quota reductions are to come first from farms owning quotas that do not have adequate tillable land to produce it; next, from farms where the quota has not been planted in 2 of the last 3 years; then, from farms where the quota has been leased away to another farm; and finally, from farms producing their own quota. In practice, the last two categories were combined for the 1982 and 1983 quota poundage reductions to give producers a chance to adjust to the new regulations. The 1984 and 1985 poundage reductions are to be made by category. The major change that occurred with the passage of the 1981 Act was the abolishment of acreage allotments, so that anybody can now raise peanuts.

The two-price support program initiated with the 1977 Act set the quota support level at a minimum of $420 per ton. The support for 1978 and 1979 remained at this $420 level and was raised to $455/ton for the 1980 and 1981 crops. The 1981 Act increased the minimum quota support level to $550 per ton. The quota support has remained at the minimum for the 1982-84 crops. Increases in the quota support are based on cost of production, not including the cost of renting or buying quota, but not to exceed 6 percent annually. Peanuts are the only field crop for which support price adjustments are now based on cost of production, by law.

Peanuts raised in excess of quota allotments are referred to as "additionals." The support rate for additionals is based on demand for crush and world market conditions. This support is to be set so there is no cost to the Government. The support level for additionals does not have a minimum floor.

Additional peanuts were supported at $250 per ton for the 1978, 1980, and 1981 crops and at $300 per ton for the 1979 crop. The additional support was lowered to $200 per ton for the 1982 crop and $185 per ton for the 1983 and

1984 crops. The Secretary of Agriculture is required to announce the support rate for additional peanuts by February 15 of each year. Traditionally, the quota support rate is usually announced at the same time. In addition to the two support rates, CCC has been announcing a minimum resale price, below which it will not sell any of its stocks for export. This policy has assured exporters that CCC will not come into the market and undercut them, after they have already signed contracts. The CCC minimum resale price for export has ranged from $400/ton to $475 under the 1977 and 1981 Acts. For the 1984 crop the minimum CCC resale price is $425 per ton. What about the future? The provisions of a minimum acreage allotment of 1.61 million acres and support based on 75 to 90 percent of parity are still in the statutes and the peanut program will revert to them unless changed, or held in abeyance, in the 1985 Farm Act. Thus, the options for a new peanut program range from a free market to a program based on allotments and parity. A reversion to permanent legislation would lead to surplus production and high government costs. An important issue under reversion to permanent legislation would be the granting of an exclusive right to a high price support to historical holders of an allotment or quota.

Several issues are raised by proposals to continue the current two-tier poundage quota program:

- What would be the effect of further reductions of the quotas?

- What criteria would be useful for determining by how much?

- What would be the effects of different levels of support prices (for both quota and nonquota peanuts)? Government cost, consumer cost, and grower returns would be affected by this decision.

- What would be the effect of changing, eliminating, or keeping the contract deadline for additional peanuts for export?

- Should the poundage quota be allowed to be sold across county and State lines?

- How can buyers assure themselves of domestic supplies, now that the poundage quota level is below demand?

Now let's shift our focus from the peanut program to a brief overview of the structure of the peanut industry.

Structure

Geographic Distribution of Production

There are three peanut producing regions: the Georgia-Florida-Alabama (GFA) region or the Southeast, the Texas and Oklahoma region or the Southwest, and the Virginia/North Carolina region, also known as the Virginia-Carolina region. Seven States grow 98 percent of the U.S. peanut crop. Georgia is the leading peanut-producing State, accounting for about 40 percent of U.S. production. For 1981-83, the Southeast produced 65 percent of the peanuts, the Southwest 16 percent, and the Virginia/North Carolina region 19 percent (table 1).

Table 1. U.S. peanut production

Region	1951-60	1975-77	1981-83
		Percent	
Southeast	49.2	62.3	64.8
Southwest	17.7	18.8	15.9
Virginia/N. Carolina	33.1	18.9	19.3
	100.0	100.0	100.0

During the last three decades, the Southeast's share of U.S. production increased, the Southwest's share remained relatively stable, and the Virginia/North Carolina share dropped. Total peanut acreage began trending downward with the implementation of declining poundage quotas in 1978. The poundage quota is still the most important factor; but, in the absence of acreage controls, the regional distribution of peanut acreage is subject to change. Acreage is most likely to rise in Georgia and Florida, since these States have cost and soil advantages.

Structure of Peanut Farms

According to the Census of Agriculture, 27,854 farms harvested peanuts in 1978. Of these farms, 25,686 were located in the seven major peanut producing States. The number of farms harvesting peanuts dropped to 21,468 in the seven major producing States in 1982. The harvested

acreage per farm increased from 54 acres to 56 acres between 1978 and 1982 in these States.

Of the farms harvesting peanuts in 1978, nearly 70 percent had harvested acreage of less than 50 acres and less than one percent had harvested acreage of over 500 acres (table 2)[1/]. Of the peanuts harvested, over a third came from farms harvesting an average of 100 to 249 acres. The large number of farms harvesting less than 50 acres of peanuts accounted for about 22 percent of the total harvest.

Table 2. Number of farms harvesting peanuts and pounds of peanuts produced by harvested acreage-size distribution, 1978

Harvested peanut acres	Number of farms	Percent	Million lbs	Percent
1-49	19,193	68.9	789	21.8
50-99	4,503	16.2	798	22.1
100-249	3,343	12.0	1,243	34.4
250-499	689	2.5	564	15.6
500-999	115	.4	185	5.1
1,000/over	11	*	37	1.0
Total	27,854	100.0	3,616	100.0

* Less than 0.05 percent.

The number of farms harvesting peanuts fell nearly 30 percent from 1974 to 1982 in the seven major peanut producing States. The average acreage harvested per farm increased from 44.1 acres in 1974, to 54.2 acres in 1978, to 56.2 acres in 1982 in these States. The increase in yield is reflected in the increase in production per farm from 103,000 pounds in 1974, to 137,000 in 1978, to 148,000 in 1982.

Types of Peanuts

Three main types of peanuts are grown in the United States--runners, Virginia, and Spanish. The Southeast region grows mostly the medium-sized kernel runner peanuts. The Southwest region grows two-thirds Spanish

1/ Detailed information from the 1982 Census of Agriculture is not yet available.

and one-third runner. The Virginia-Carolina region grows mostly the large-kernel Virginia peanut. A fourth type, the Valencia, is grown only in New Mexico.

In 1982, runners accounted for about 67 percent of peanuts used in domestic edible products; Virginia peanuts accounted for about 25 percent; and the Spanish variety accounted for about 7 percent (table 3).

Table 3. Peanuts used in edible products

Variety	1980-81	1981-82	1982-83
	Million pounds, shelled basis		
Runner	871	990	992
Virginia	99	138	215
Spanish	106	97	102
Inshell varieties 1/	90	151	155
Totals	1,166	1,376	1,464

1/ Inshell X 0.7519 = shelled basis. Most peanuts sold in the shell are Virginia peanuts. Valencia peanuts are also used.

Peanut Markets

An overview of peanut markets involves both domestic and foreign outlets.

Edible Peanuts

Peanut manufacturers produce three principal products: peanut butter, packaged nuts, and peanut candies. About one-half of all peanuts processed in the United States for edible purposes are used in the manufacture of peanut butter (table 4). Packaged nuts account for almost one-third of all processed peanuts; some of these are roasted and packed in the shell, commonly referred to as "ballpark" peanuts, while a much larger quantity are used as shelled peanuts packed as dry roasted peanuts, salted peanuts, or salted mixed nuts. Peanut candy accounts for about 20 percent of all processed peanuts. Peanuts constitute one-third of all the shelled nuts used in candies.

As shelled peanuts, Virginias are used as cocktail nuts and salted peanuts. Unshelled Virginia peanuts are roasted for use as "ballpark" peanuts or cleaned inshell peanuts. As shelled peanuts, Virginias are limited in use for other peanut products because they are more expensive than other varieties. The medium-sized kernel of the runner peanut and the small kernel of the Spanish peanut are mostly used in making peanut candy and peanut butter. Runners, however, are increasing in importance for all uses and they are beginning to compete with the Virginia peanut in the large-kernel market. The Valencia peanut with its long shell containing three or four kernels is excellent for roasting in the shell.

Table 4. Food uses of peanuts

Products	1980-81	1981-82	1982-83
	Million pounds, shelled basis		
Peanut butter	589	654	678
Salted peanuts	205	278	308
Peanut candy	238	256	284
Sandwich snacks 1/	24	22	22
Other uses	20	15	17
Cleaned, in-shell 2/	90	151	155
Totals	1,166	1,376	1,464

1/ Peanut butter sandwich snacks sold commercially.
2/ Inshell X 00.7519 = shelled basis.

Peanut Oil and Meal

In addition to edible uses, the peanut can be crushed into oil and meal. Peanuts rank among the world's principal oilseeds, but contribute only minor quantities to the availability of edible oil and protein meal in the United States. In 1980-82, the peanut crush averaged 454 million pounds, or about 14 percent of peanut production. In comparison, soybeans crushed for oil and meal totaled more than one billion bushels (60 billion pounds).

In general, "oilstock" peanuts are those that have been rejected or diverted from edible channels. Diversion may be due to oversupply of a certain variety. Rejections include "pick-outs" from edible nuts and other low-quality

peanuts such as Segregation 3 peanuts--peanuts containing a visible toxin-producing mold. Rejects also include improperly stored peanuts that became weathered (shriveled and wrinkled), infested by insects, or moldy.

U.S. Peanut Exports

In 1980-82, peanuts accounted for 8 percent of world oilseed production and 3 percent of world oilseed trade. The United States is the major world exporter of edible peanuts (table 5). Although we account for only about 10 percent of world peanut production, our share of world trade is almost one-half. U.S. peanut exports have risen more than elevenfold since the early 1960's to an average level of 323,000 metric tons (inshell basis) for 1980-82. About 75 percent of U.S. peanut exports are for edible use; 25 percent are oilstock exports for crushing. The value of peanut exports averaged $177.3 million, for fiscal years 1980-82 or 2.6 percent of U.S. oilseed export earnings during this period. About 25 percent of the U.S. peanut crop was exported in the early 1980's, compared to around 3 percent in the early 1960's and 15 percent in the early 1970's.

Table 5. Peanut exports from specified countries

Country	1977 1978	1978 1979	1979 1980	1980 1981	1981 1982	1982 1983
	1,000 metric tons, shelled basis					
United States	465	518	479	228	261	333
China	30	40	42	150	100	125
Sudan	197	67	32	80	80	80
South Africa	90	26	100	67	36	57
Senegal	50	50	75	70	45	45
India	0	27	26	71	46	60
Others	164	173	75	254	261	127
Total	996	901	829	920	829	827

Prior to 1970, U.S. exports of peanuts averaged less than 100,000 tons annually and accounted for less than 5 percent of world trade. Most of these shipments went to Canada as edible nuts. U.S. peanut exports jumped in 1971 andexpanded rapidly during the 1970's in line with rising domestic supplies, reduced marketings from the principal

African exporters (Nigeria and Senegal), and increasing demands in Canada, Western Europe, and Japan.

In 1980, after severe drought reduced the U.S. peanut crop to its lowest level in 17 years, exports dropped sharply. The worldwide recession in the early 1980's and the strong U.S. dollar slowed the recovery of U.S. peanut trade by keeping demand down. In 1980-82, the principal destinations of U.S. peanuts were the European Community (EC) (55 percent), Canada (20 percent), and Japan (8 percent).

Peanut shipments by other exporters (mainly Sudan, China, and India) fluctuated widely during the 1960's and 1970's, primarily reflecting the volatile nature of peanut production in these countries. Sudan accounted for a sizable share of the world market during most of the 1970's before dropping off in 1979 as a result of reduced supplies. China emerged as a major exporter in 1980 with sales to Japan and other Asian countries and small shipments to Western Europe. High peanut prices brought on by the drought-stricken U.S. crop, policy incentives for expanding oilseed production, and the opportunity to increase foreign exchange earnings were the primary motivating factors for the sharp increase in Chinese peanut exports.

Historically, the primary outlets for world peanut exports have been the large markets of the EC and other Western European countries, particularly Portugal and Switzerland. These markets, however, declined throughout the 1970's, while shipments to the Soviet Union, Canada, and Japan increased.

Exports of Oil and Meal

Traditionally, the bulk of the world production of peanuts outside of the United States has been crushed into peanut oil and meal. Peanut oil is the higher valued product and, therefore, the primary output of the peanut crushing industry.

World trade in peanut oil, while fluctuating widely from year to year, trended upward during the 1960's and early 1970's in line with growing world demand for vegetable oils. World exports peaked in 1977 and have been down significantly in the early 1980's, as a result of smaller excess supplies in traditional exporting countries and increased competition from other oils.

U.S. peanut oil exports accounted for about 3 percent of world edible oil trade in recent years. Senegal, Argentina, the EC, and Brazil are the leading peanut oil suppliers. U.S. exports of peanut oil are small (5-10 percent of world trade) and fluctuate widely from year to year. Exports as a share of production have been volatile, ranging from as low as one percent in 1962 to 24 percent in 1978 to around 15 percent in recent years. U.S. export earnings from peanut oil averaged $13.3 million for fiscal years 1980-82, or about one percent of total vegetable oil earnings during this period. About 75 percent of U.S. peanut oil exports go to the EC and about 25 percent to Canada. U.S. exports declined in the early 1980's due to the drought-reduced 1980 crop, the global recession, and the strong U.S. dollar which dampened sales.

Peanut meal, the other product from crushing peanuts, is used primarily as a protein supplement in livestock feed rations. Because peanuts are primarily crushed for the higher valued oil, the supply of peanut meal is largely influenced by developments in the fats and oils market. World trade in peanut meal has been highly variable over the past 2 decades, reflecting year-to-year fluctuations in world peanut production and crush. Trade has declined in recent years as a result of reduced crush due to competition from other vegetable oils. The U.S. consumes essentially all its peanut meal domestically.

The Export Outlook

Attempts to expand trade in peanuts and peanut products during the early 1980's has been limited by:

1) high prices and volatile production in some major exporting countries;
2) the erosion of purchasing power stemming from the global recession;
3) depreciation of many currencies against the dollar; and
4) high interest rates, scarcity of foreign exchange, and credit problems in financing imports in a number of developing and centrally planned countries.

Prospects for expanding trade will hinge largely on the resolution of these problems. Prospects for the expansion in U.S. peanut exports will depend on competition from other producers and on the market for edible nuts, where competition will come from tree nuts (almonds, cashews, hazelnuts, Brazil nuts, walnuts, and pecans) as well as

snack foods. Developments in the fats and oils sector are likely to reduce the importance of peanuts as an oilstock. Expanded production and consumption of cheaper vegetable oils--particularly soybean, palm, rapeseed, and sunflower--are likely to displace peanut oil or force prices lower. Moreover, the growing awareness of the potential for aflatoxin contamination in peanut meal has given rise to import restrictions in many countries.

Current Situation and Outlook

The current situation and outlook for peanuts is highlighted by the sharp increase in planted acreage.

1984 Acreage Up

The June Acreage report indicated that planted acreage is 1,546,000 acres, up nearly 10 percent from last year and earlier planting intentions. This acreage increase reflects a strong contract market for additional peanuts that prevailed prior to planting. The deadline for signing contracts for additional peanuts was April 15.

Increased acreage is indicated in all three major peanut production acres, with the Southeast increasing 14 percent, Virginia-Carolina, 4 percent, and the Southwest, 4 percent. The Southeast accounts for about 60 percent of the planted acreage in 1984.

1984 Crop

Given normal yields, total peanut supplies for 1984/85 will be at their highest level since the 1976 crop (table 6). Total use is estimated to be 3,870 million pounds, leaving a large ending stock of 850 million pounds. Exports are expected to be about 900 million pounds and continue their strong upward trend since the sharp drop in the export market due to the drought-reduced 1980 crop. Exports will still be below the record levels of over one billion pounds reached in the 3 years prior to the drought. The strong export demand was reflected in the contract market for additionals, prior to plantings probably averaging over $400 per ton this year. Domestic food use is expected to continue its gradual increase in 1984/85.

Many traditional customers diversified their sources of supplies after the market interruption caused by the drought, but the United States is rapidly recapturing its dominance as a reliable supplier of quality edible peanuts.

1983 Crop

In contrast to the expected abundance of peanut supplies in 1984/85, peanut supplies to close out the 1983/84 crop are tight. Ending stocks have been lowered to 670 million pounds. Ending stocks are used for processing until peanuts from the new crop are available in early fall. The lower stock estimate reflects an increase in seed use from the current crop to plant the increased 1984 acreage. Expected crush has also been increased slightly.

Table 6. Supply and utilization

	1979	1980	1981	1982	1983	1984
			Million pounds			
Stocks-8/1	586	628	413	757	864	670
Production	3,968	2,303	3,982	3,440	3,296	4,050
Imports	1	401	2	2	2	--
Total Supply	4,555	3,332	4,397	4,199	4,162	4,720
Exports	1,057	503	576	681	775	900
Crush	571	446	574	341	393	542
Food	2,028	1,647	1,933	2,056	2,090	2,150
Residual	271	323	557	257	234	278

PANEL 1: Developing and Emerging Technologies for Peanut Production and Management.
D. M. Porter, Chairman

Breeding and Genetics
J.C. Wynne

Peanut yields have increased from about 728 kg/ha in 1930 to more than 2850 kg/ha. This more than 5 percent a year increase has been due to a package of production practices and improved cultivars. However, increases in recent years have been slight suggesting that research efforts to increase productivity must be accelerated. One opportunity to accelerate progress is to utilize some of the new technologies in peanut research programs.

The present constraints to increased yields and greater profits are losses to insects, diseases, and unfavorable environments, primarily drought. In addition to these factors which reduce yields, the genetic yield potential of peanut cultivars should be increased. Development of improved peanut cultivars could reduce these constraints and increase yields and profits from peanut production. Biotechnology will offer new tools to breeders that will greatly expand the available gene pool and accelerate the peanut breeding process. Peanut breeders, however, are in the position of needing to concentrate on classical plant breeding procedures and at the same time prepare to utilize the new technologies that are being developed for crop improvement. Research in five major areas is needed to allow peanut breeders to incorporate new technologies into their peanut improvement programs. These five areas are as follows:

Identify Gene(s) for Important Agronomic Traits

Cultivated peanut and *Arachis* spp. germplasm should be evaluated for resistance to diseases (cercospora leaf-spots, rust, southern stem rot, pod rots, root-knot nematodes, and *Aspergillus flavus*) and insects; tolerance to environmental stress factors (drought and salinity); and improved quality (fatty acid and amino acid composition, and blanching). The inheritance of each trait and the relationship of each trait with other desirable traits should be determined for each germplasm source.

Develop Efficient and Effective Selection Methods for Modifying Traits

In order to develop better selection methods for disease and insect resistance, the genetics and population dynamics

of pathogens and insects should be investigated. Studies need to be conducted on mechanisms of drought tolerance and their inheritance as well as the genetics of other important traits. The genetics of host-pest interactions including diseases, insects, and Rhizobia should be determined. Research should be conducted to develop selective culture media for isolation of cells tolerant to toxins or environmental stress. Methodologies to regenerate protoplasts into whole plants would also be needed.

Develop Methods for Transfer of Desirable Genes Between and Within Species

The use of conventional breeding procedures allowing more recombination such as recurrent selection, convergent cross or backcross-single seed descent should be investigated for cultivated peanuts. Research is needed to improve hybridization efficiency by chemical and environmental manipulation, to double chromosomes more efficiently, to rescue embryos, and for species-bridging techniques in the species of *Arachis*. Methods for cell culture and plant regeneration are needed for use with cultivated and wild species of *Arachis*.

Develop More Effective Reproductive Systems(s)

Research in this area is needed to develop a better understanding of basic reproductive biology, including reproductive morphology, physiological control of reproductive processes, and inheritance of variants in the reproductive process. Novel reproductive methods such as apomixis and sterility-fertility systems should be exploited to develop new gene combinations and cultivars.

Develop Basic Understanding of Organization of Plant Genome and Gene Structure

Cytogenetics should be used to investigate chromosome morphology, aberrations, and gene mapping. Research to increase knowledge of genetic recombination and develop more efficient use of recombination with conventional breeding procedures is required. This research is needed to allow peanut breeders and geneticists to incorporate new and emerging technologies into their crop improvement programs. Furthermore, it would provide the basic information needed to effectively apply plant biotechnology (recombinant DNA) to peanuts when methods are developed for crop plants. The greatest hurdles to accomplishing this research in peanuts are the lack of

manpower and funding, neither of which will likely be improved in the near future.

Production and Management Systems
R.J. Henning

Situation and Future Developments

Plateauing peanut yields coupled with reduced parity prices and increased production costs continue to bring about changes in the U.S. peanut industry. The peanut producer of tomorrow may bear little resemblance to the past, especially if legislation continues the present trend. Tomorrow's peanut producer (in the southeast) will likely be farming more land, using larger and more sophisticated equipment, and have a higher degree of skill in management, economics, production, and marketing. Production areas will likely shift within and among States and acreage will accumulate in areas with sandy and sandy loam type soils with irrigation potential. Production will become totally market oriented through forward contracts with shellers and/or manufacturers for both domestic and export and marketing.

To meet the challenge research and extension must zero in on emerging problems characteristic of "High Tech" production utilizing the technologies which are emerging in our "Space Age" culture.

Emerging Technological Opportunities and Needs

The following is a summary of the combined inputs from peanut extension, research and industry people across the U.S.

A. Production

Economics
Research and extension for the future must be based on two levels of economics--domestic and export. Producers must utilize the prescription approach to input management.

Computerized crop production
Computers will become commonplace in the farm office and will be utilized in planning least cost production schemes, cropping alternatives, pest control programs, irrigation scheduling, plant growth models, plant and soil nutrient application, optimum harvest maturity, equipment monitoring and marketing decisions. This will mandate the development of software and education programs to facilitate their use.

Biological pest control agents

Continued social pressure for clean water and environment will likely increase restrictions on the use of chemicals for pest control. Biological controls will become more popular. Opportunities appear to be good for the development of certain bacteria for foliar diseases, fungi for weed control, as well as beneficial insects for undesirable insect infestations.

Systemic fungicides

Fungicides which are curative in nature and thus applied only on demand as indicated by scouting techniques will be possible.

Improved weather forecasting

Space satellite observation stations along with receiving discs and computers will allow producers to better plan planting and harvesting schedules. Also, continual monitoring of the crop micro-climate via sensors and computer integrated circuits facilitate prescription pest control based on existing conditions. The use of radar will allow monitoring of insect flights and infestation potentials.

Resistant peanut germplasm

The development of peanut cultivars resistant to disease, nematodes, insects and drought will continue to be of high priority.

Plant protection systems

Foliar application of protective polymers to prevent disease infection are becoming possible. These, along with plastic ground cover and trickle irrigation, may be feasible in the future to enhance yields with lower input costs.

Harvesting technology

Once-over and gleaner-type combines are emerging on the horizon. Research is needed to optimize the use of this equipment.

Minimum tillage/double cropping

Economic pressures continue to cause growers to look favorably at double cropping schemes involving some type of minimum tillage operation. Research is needed to determine the best system(s) and if the pest control programs should be altered.

B. Marketing

Forward contracts

It is likely that most, if not all, serious peanut marketing will be in the form of forward contracting negotiated prior to planting. Manufacturers and other end users will likely be contracting directly with farmers through a local sheller to produce a specified quantity and quality of peanut to fill a predetermined market. This may reflect a need to develop specific cultivars for specific markets (both edible and oil, domestic and export).

On-farm storage

Growers in some producing areas may need to store peanuts produced above contracts in on-farm storage. Research on pest and environment management to maintain quality is needed.

C. Utilization

Increased feed use

Research is limited and should be expanded in the future to demonstrate the profitable use of peanut foliage as livestock feed (tests on pelletizing, haylage, etc.). Also, research should be extended on the use of peanut meal as a protein supplement for cattle, hogs and poultry. Cooperative research with plant breeders may be needed to improve protein quality.

Increased oil utilization

Additional research on the use of peanut oil as a crop oil concentrate is needed.

Pathology
D.M. Porter

Introduction

Peanuts have long been plagued by disease. A recent estimate indicated that losses due to peanut diseases in the United States exceeded $212 million in 1983. Efficient production of peanuts in the United States in the future will depend to a large extent on disease control strategies. The successful peanut grower must be a good disease manager as well as a sound business manager. Disease control strategies will depend on his knowledge of who, what, when and where his "enemy" (causal organism) is and the approaches available to him to combat each situation. Strategies for controlling specific diseases will undergo drastic changes in the next decade.

Pesticides and Their Use

As in the past, pesticides will have a distinct place in future control strategies. Millions of dollars are spent annually on fungicides and nematicides in the United States. Future strategies will minimize fungicide and nematicide usage. By using the "prescription" approach rather than the "preventative" approach, fungicides and nematicides will be used only when dictated by need (visual observations in the field). By using the "forecasting" approach, pesticide usage can be further curtailed. Pesticides will be applied only when prevailing environmental parameters favor the growth and development of a specific pathogen. The indirect beneficial and detrimental effects of all pesticides used in peanut production must be thoroughly understood. Herbicides and/or insecticides possessing fungicidal properties may be used under certain situations to kill either weeds or insects and simultaneously suppress disease development to a manageable level. Since some pesticides enhance the development of nontarget pathogens, care must be practiced in proper pesticide selection. Fungicides with different modes of action are now being developed. These new generation fungicides act primarily on the plant and not the pathogen. Control of the pathogen will result since the plant's mechanism of defense is stimulated and phytoalexin production is increased.

Biological Control

New frontiers are being opened in the area of biological control of peanut plant pathogens. Leafspot fungi can be controlled effectively with bacteria (*Pseudomonas cepia* and *Bacillus thuringiensis*) and the fungus *Dicyma* sp. Root decay by *Rhizoctonia* spp. and *Fusarium* spp. can be controlled effectively by seed treatment with *Bacillus subtilis*. *Glomus* sp., a mycorrhizal fungus, can significantly reduce the infection levels of *Sclerotium rolfsii*.

Disease Predictive Models

Based on knowledge of the biology of a specific pathogen and the economics of production, it is possible to make reliable predictions about future disease situations. Microcomputer programs can serve as management tools for predicting disease development and dictate proper courses of action.

Remote Sensing

Remote sensing can be used effectively to determine identity, spread, and severity of a specific disease. Remote sensing can be used to give reliable estimates on disease losses. In the future remote sensing might be used as a management tool to dictate possible courses of action to take against specific pathogens. Provided evidence of a disease could be noted sooner on infrared photographs than by visual means, control measures could be initiated at an earlier date to minimize pesticide usage.

New Methodologies for Germplasm Screening

Knowledge of the exact toxins secreted by a pathogen during the infection process might be used in screening peanut germplasm for resistance to that pathogen.

Antioxidate Usage

The development of antioxidates to be used against the toxins (oxidates) that are produced by specific fungi holds promise as a method of disease control. The antioxidates are inexpensive and nonpolluting and could add a new realm in disease control strategies.

Summary

The future role of plant pathology in peanut production is vital to the success of the peanut growers. The developing and emerging technologies in the field of plant pathology will only add to our existing knowledge of how to produce high quality peanuts more efficiently.

Entomology
J.W. Smith

During the last 10 years research on insects limiting peanut production has increased immensely in both quantity and quality. A vast majority of the contemporary published reports have contributed to the basic understanding of the life system of the pest whereas in the past reports were mainly toward efficacy. This present trend in research is significant as it allows entomologists to understand how the insect pest functions and interacts with the biotic and abiotic components of the ecosystem.

To the question of what panaceas do entomologists have for the future of insect pest control on peanuts: Is it a new insecticide that is cheap, kills only the target insects, last a long time, yet is environmentally and medically safe?--No! Is it a genetically produced plant that has high yields and impervious to insect attack?--No! Is it a group of natural enemies recently discovered in some exotic, isolated area of South America?--No! Can we create an answer through biotechnology?--No!

I see no panacea on the horizon. Although, peanut insect integrated pest management (IPM) is a practiced, recognized, economically viable mechanism, little has changed in our approach since the early 1970's. We (entomologists) think that studying the basic life systems of insects is where the answers to the problems are hidden.

Probably the most difficult problem with managing insects is an absence of our ability to predict population densities both temporally and spatially. Most insect pests do not occur with regularity in time and space, as many of you are aware. Being able to predict economic insect outbreaks would be an excellent IPM tool.
I presently see this as being one of the major developing technologies in insect IPM. New modeling expertise coupled with recent understandings of past life systems have allowed us to develop some rudimentary predictive models.

For example, a recent model for foliage feeding insect pests predicts yield loss based on several inputs. These inputs are pest density with a species and age distribution and peanut age. Outputs include proportion defoliation and predicted yield loss. This model has been used in Texas IPM programs and found to be extremely useful and accurate. Also a model is being developed for predicting lesser cornstalk borer outbreaks. This model is in its infancy but is the result of the cooperation of five entomologists.

In summary, research thrusts need to be aimed toward the refinement of applied aspects of control; aspects of life systems which lend themselves toward population regulation; development of computerized, predictive, and mechanistic models; and interdisciplinary research. Currently, research focuses on economic or treatment thresholds, pesticides, HPR, biological control, cultural management, and life systems studies. It is apparent that current research is congruent with predicted needs.

Weeds
C. W. Swann

Peanut production technology is likely to undergo dramatic changes in the near future. Changes in tillage, marketing, and potential shifts of weed species composition are likely to dramatically influence weed management systems currently in use. Problem areas requiring research as viewed by a number of weed science research and extension personnel in the Georgia, Florida, Alabama, Virginia, and North Carolina production areas are as follows:

Reduced Tillage Systems

Research is currently underway in Georgia, Florida, and Alabama to evaluate weed management systems for peanuts grown at various levels of reduced tillage. Information gathered to this point indicates similar herbicide inputs are required for weed management in peanuts grown with either reduced tillage or conventional tillage. Long-term research is required to evaluate the effect of reduced tillage systems on weed population shifts in peanuts as well as associated disease and insect implications.

Selection of Herbicide Tolerant Germplasm

Initial research underway in Florida (Brecke) has revealed that peanut breeding lines vary in tolerance to herbicides. Certain lines have been found to have considerable tolerance to the herbicides cyanazine and prometryn. These low cost herbicides are currently being investigated for registration for use on peanuts. Utilization of herbicide tolerant germplasm in breeding programs offers the potential for development of new varieties which are highly tolerant of inexpensive but highly effective herbicides.

Control of Problem Perennial Weeds

Certain perennial weeds such as horsenettles (*Solanum carolinense* L. and *S. dimidiatum* Raf.), maypop passionflower (*Passiflora incarnata* L.), purple nutsedge (*Cyperus rotundus* L.), and others are increasing as problems across the peanut production regions of the Southeast. These weeds are highly tolerant of herbicides currently available for use on peanuts. Weed biology studies for these and other species are needed to determine the most appropriate approaches for mechanical and/or chemical control. Studies of this nature are currently underway in Alabama (Wehjte).

Prescription Weed Control

New herbicides are currently under development which will permit postemergence control of any or most weed species which are currently troublesome in peanut production. Investigations are currently underway in North Carolina (York), Alabama (Wehjte), and Florida (Brecke) to evaluate the potential of eliminating preplant, preemergence, and cracking stage treatments.

Biological Weed Control

New technology is developing which may permit control of certain problem weeds such as sicklepod (*Cassia obtusifolia* L.), Florida beggarweed (*Desmodium tortuosum* [SW.] DC), and yellow nutsedge (*Cyperus esculentus* L.) with biological control agents. Use of biological control agents offers the potential of an inexpensive approach to control of weeds which are presently controlled with costly herbicides and/or tillage treatments.

Weed Threshold Determinations

Relatively little information is currently available concerning threshold values which could be utilized to determine potential benefit of weed control operations. Weed population density values may not be sufficient parameters for decision making in weed control operations. New approaches are needed which will better define the potential for weed populations to result in economic yield loss.

Cost/Benefit Data

Peanut growers are currently carefully examining their potential for dollar return versus dollar spent in production input. Research information is needed which provides information on return of high-input, high-yield programs versus lower yield, lower input approaches to peanut production.

PANEL 2: Developing and Emerging Technologies for Peanut Harvesting, Curing, Shelling, Drying, and Storage.
J.L. Butler, Chairman

Harvesting and Curing
J.L. Butler

The operations covered by the entire panel will probably be most affected by the emerging technologies in sensor development for microprocessor control of operations and the changing of operation sequences to produce a high quality product at lower cost.

For the area of harvesting and curing (for purposes here, curing will be limited to that which takes place in the field between the time the peanuts are dug and the time they are combined), four factors will have significant impact which must be considered in any research program in this area. They are weather; soil and water conservation; energy; and microprocessors and sensors.

These will be considered separately.

Weather

Since we cannot control the weather, we must monitor it very carefully and feed this information into a computer to help make decisions. Site specific information must be gathered. For example, with microclimate information specifically for one field, the rate of moisture loss can be monitored, this information can be evaluated against the weather forecast to allow intelligent decisions to be made for combining operations. As weather forecasting becomes more exact (it is now 20 percent better than flipping a coin for rain vs. no rain), the need for microclimate data will become increasingly important in producing a high quality peanut for the minimum cost.

Soil and Water Conservation

As improved soil and water conserving practices take place, their impact on the quality of the harvested peanut may be significantly affected. More crop residue will produce more foreign material unless improved harvesting methods are developed. The planting of peanuts in stubble may cause problems in digging, especially. The root system of the stubble may be only partly decomposed and, as a consequence, the digger blade may be overloaded causing additional digging losses. Narrow row spacing may require significant changes in the inverter mechanism in order to do an adequate job of inverting.

Energy

When we consider that a finite resource, petroleum, is rapidly being depleted it is prudent to assume that the cost of petroleum based fuels will increase dramatically. As a result, the mobile operations such as digging and combining must be designed to conserve the maximum amount of energy. Perhaps the cleaning operation, normally done at the combine, will be designed to conserve the maximum amount of energy and will be converted to a stationary operation which can use a cheaper source of energy. The drying operation needs to be examined for efficiency. Perhaps shelling before drying would be practical, especially if combined with a packaging process (such as the CO_2 imbibing process developed at the NPL) to eliminate the need for further insecticide treatments and greatly reduced refrigeration costs. A separation of the edible grade and the oil stock grades could also be made prior to drying and the oil stock grades could be dried with less care, again conserving energy.

Microprocessors and Sensors

These new technologies greatly increase the capabilities of individuals to control processes. They are completely changing the ideas of economics of scale. With the development of the proper sensors, all operations of agricultural production can be monitored and most can be controlled. This will result in the capability to produce a higher quality product at a lower cost. Along with this capability comes the opportunity for the producer to increase the value of the crop by additional processing before marketing. With the financial bind in which the farmer finds himself, and ironically frequently under employed as evidenced by the increase in part-time farmers, we must not overlook this potential for microprocessing and sensors.

Drying

J.M. Troeger

Peanuts are normally removed from the soil with a moisture content in excess of 40% (wet basis) and must be dried to a safe storage moisture level of 10% or less. Peanuts are usually partially cured in the windrow, then drying is completed after combining by blowing heated air through the peanut mass in a bin or wagon. Field drying reduces the energy needed to remove the moisture but exposes the peanuts to risk of loss or damage from weather or other natural conditions.

The primary objective of peanut drying research is to produce the highest quality product at the least cost. This requires an interdisciplinary effort to develop the methods and equipment and to evaluate the results. Quality can have several meanings depending on the ultimate use. Most peanuts grown in the United States today are used for food so such quality values as flavor and shelf-life are important. Some peanuts are used for seed so the drying process should produce peanuts with high germination. A growing number of peanuts are being used for oil. Research is needed to determine proper drying procedures for these peanuts. Perhaps a harsher but more economical drying procedure would suffice.

Some areas of profitable peanut drying research might include:

Energy

Energy is a critical component of the drying process. Lack of an adequate energy supply for drying may result in poor quality of peanuts. To assure an adequate supply of energy, researchers in all three peanut growing areas have been looking at solar energy as an alternative energy source. Heat pumps have been considered as a means of reclaiming energy in exhausted drying air. Better ways of controlling the drying process to conserve energy, such as partially recycling the air or interrupting the airflow periodically, are also being considered.

Quality

Drying or curing the peanut involves certain chemical and physiological changes that are affected by the temperature and rate of drying. Early researchers determined that continuous drying with air temperatures about 35°C resulted in off-flavors and poor milling quality. Research to date allows us to recommend temperatures and relative humidity limits which will produce a high quality peanut with good flavor and milling quality for mature peanuts. When the maturity varies within a lot, overall quality of the lot may suffer. Food scientists have examined a number of ways to measure peanut quality but we are just beginning to be able to relate certain drying procedures with a given quality standard. New techniques, such as heating with microwaves and drying under a partial vacuum, look promising as a means of maintaining quality.

Simulation Models for Drying

Development of mathematical models help us to better understand the drying process. Several researchers have proposed models which adequately describe the time-moisture relationship as well as energy use during drying. Models which describe drying in the windrow as well as drying with forced, heated air are available. These models have been validated with experimental results. Development of models requires the availability of certain basic data such as thin-layer drying equations, equilibrium moisture-humidity relationships, specific heat and others. Models are a tool that the researcher can use to explore how changes in the drying process may affect the results. When the relationship between quality measurements and drying parameters are quantified, these relationships can be included in the model.

Controls and Sensors

Peanut dryers today have thermostats to limit the temperature. The wide availability of the inexpensive microprocessors opens the possibility of more precise control of the drying process. Researchers are just beginning to explore some of the possibilities available with this new technology. Used in conjunction with a simulation model, a number of control procedures may be examined with the most promising tested under experimental conditions to determine their effect on quality. Controllers, however, are no better than the sensors that feed information to the controller. Temperature sensors are fairly reliable. Monitoring the moisture content, however, is not easily implemented. Researchers currently are considering moisture monitoring by weight change or humidity changes in the exhaust air.

Economics

When is the best time to harvest? Maturity of peanuts within a crop will vary on any given day. Several researchers are developing better methods of determining when the overall maturity reaches a peak to maximize production. What is the proper balance between windrow and wagon drying? Leaving peanuts in the field to dry will save costly energy but this must be balanced against losses and damage from weather and other natural occurrences.

Research in peanut drying has a number of challenges. Basic procedures have been defined but changing

situations and new technologies present new problems and new opportunities.

<u>Shelling</u>
J.I. Davidson, Jr.

As the peanut industry moves toward a free market system, the peanut shellers assume extraordinary risk because they must contract with the farmers to supply them with an estimated supply for their domestic and foreign buyers. The farmers do not have to supply the contracted amount if adverse weather prevents them from producing the agreed amount. Yet the sheller must supply the contracted amount to their buyers. In addition their buyers are implementing higher quality standards and demanding increased uniformity in size and shape. These trends have resulted in higher risks and higher fixed and operating costs for the shellers. Small shellers are going out of business. Shelling plants are becoming fewer and larger.

Emerging technologies such as microcomputers, microelectronics, robotics, systems engineering, lasers, x-ray, ultrasonics, and biotechnology offer considerable opportunities to deal more effectively with the trends.

Microcomputers and software can be developed to store, recall, and utilize scientific and economic information to reduce risk. Models can be developed to predict yields, grades, aflatoxin, foreign material, outturns, supply, demand, and value. Microcomputers, sensors, and robotics can be used to automate plant operations to reduce cost, eliminate human error, and provide better quality control. Systems engineering research can optimize plant design and operations to reduce cost and provide higher outturns and better quality peanuts. Laser, x ray, and ultrasonic technology can be useful in developing new methods of shelling and separation to provide higher outturns and better quality peanuts. Biotechnology may provide varieties with more acceptable shelling, separation, and marketing properties requiring less equipment and producing better quality peanuts. Researchers and industry must make use of these and other emerging technologies to reduce risk and to provide the lowest price and best quality peanuts to United States and world markets.

<u>Storage</u>
J.S. Smith, Jr.

Investigations into new and improved methods, techniques, and facilities to reduce aflatoxin contamination and quality deterioration during peanut storage are needed. Underground or semiunderground facilities appear to offer a more uniform temperature during storage with perhaps

better insect and rodent control. Ventilation systems, mechanical and natural, need studying to determine ventilation requirements throughout the storage period. Air flow or exchange rates need to be determined for the various periods of storage.

Most peanut storages consist of a steel superstructure covered with a single layer of galvanized sheetmetal. This type of storage provides little insulation from the day to night temperature fluctuations and is most often the surface where condensation occurs. The high temperature reached during the day from solar radiation elevates the temperature of the peanuts in proximity to the sheetmetal, thus causing rancidity and other quality deterioration. A suitable insulation material and method of application needs to be determined to prevent condensation and temperature increases from solar radiation while providing a durable surface not easily damaged or which creates a haven for insects.

Improvements are needed in warehouse loading to prevent peanut damage and provide better initial cooling of peanuts going into storage. Partial vacuum and/or inert gas atmospheres need to be studied at a pilot storage level to determine the feasibility of these atmospheres for storing peanuts for extended periods without refrigeration, inshell and shelled.

Fail-safe microprocessor based controls need to be studied and adapted to control the environment within peanut storages to prevent condensation, excessive moisture buildup or depletion, and maintain desired temperature levels.

A different method or technique for determining the moisture content of peanuts going into storage is needed to prevent the mold growth and possible aflatoxin contamination. The present method does not take into account the high-moisture content of the hulls of immature and "raisin" pods which are often covered with mold shortly after warehousing. These kernels and pods are often greater than 15 percent moisture content, but the kernels contribute little weight in the sample and therefore, have little effect on the average kernel moisture content in present sampling procedures.

The thermal properties of peanuts need further investigation, especially in the 5 to 10 percent moisture content range which is the moisture range of concern during storage. This information would help in the design

and operation of storage facilities to maintain peanut quality for extended periods.

Storage conditions greatly affect seed quality, and better control of these conditions is needed to provide quality seed for growers to obtain optimum germination with good healthy plant growth. Further research into storage effects on seed and operation of storage facilities to provide the best possible seed for planting is needed.

Insect Control in Stored Peanuts
L.M. Redlinger

Introduction of parasitic and predaceous insects shows promise as a future method of pest control in stored farmers stock peanuts. Several such beneficial insect species occur naturally in peanut warehouses, and their numbers could be augmented by periodic releases to effect pest control. The effectiveness of this method was recently demonstrated by a pilot test conducted in commercial warehouses. In this test, two beneficial insects, one predator and one parasite, suppressed populations of the almond moth and Indianmeal moth, and reduced damage to peanut kernels more effectively than did the conventional malathion treatment. The advantage of biological control is, of course, that it circumvents the problems of insecticide resistance and toxic residues and, at the same time, poses no new problems. Introduced beneficials cause no damage to stored peanuts, and their remains are removed during the cleaning and shelling processes.

Other biological control methodologies, such as insect growth regulators (IGR) and pathogens also have gained considerable interest in the past several years. The insect growth regulator, methoprene, has been registered for the control of certain stored-product insects on peanuts. It is applied on peanuts as they are stored in a manner similar to the way malathion is applied. However, unlike traditional pesticides, methoprene does not result in immediate insect kill; instead it acts on the last larval instar to inhibit normal development to the pupal stage. IGR's are not toxicants and do not cause death in larvae or adults. Population increase is controlled by eliminating further generations of adult pests.

The microbial pesticide, *Bacillus thuringiensis*, or Bt, is one of the naturally occurring bacteria that is found in most regions of the world. Bt exhibits a unique insecticidal-like activity when consumed by susceptible larvae, specifically those of the insect order

Lepidoptera, which includes the almond and Indianmeal moth. The larvae ingest the Bt crystals and usually are killed in 1 to 4 days. Sublethal doses usually cause digestive disruption resulting in nonfeeding and death by starvation.

Research on the use of modified atmospheres to control stored-product insects has increased greatly in the past 10 years. This interest may have been generated because of the increasing problem of insect resistance to conventional insecticides and fumigants and also because of the residues associated with the use of these products. The use of modified atmospheres shows promise in controlling both insects and aflatoxin production in stored peanuts. The Environmental Protection Agency has granted an exemption from tolerance for the use of modified atmospheres on all raw and processed agricultural commodities.

Irradiation of grain and oilseeds for insect control has received new interest in recent months as the threat of losing some of our common fumigants materializes. Irradiation of commodities takes less time than fumigation, leaves no residue, and when properly done is as effective in controlling insect infestations as any other procedure now available. Tests over many generations of insects have provided no evidence that insects develop resistance to irradiation. A practical level of insect control in bulk peanuts could probably be achieved by a sterilizing dosage of 20 to 25 krad treatment and complete disinfestation could be achieved by a 40 krad treatment.

A pilot-scale microwave/vacuum grain dryer was tested for use in insect control of grain and it shows considerable promise at maximum intensity and at 35 torr pressure.

The new peanut protectant, pirimiphos-methyl (Actellic®), is now available for use under an Experimental-Use-Permit. Pirimiphos-methyl is active against a wide range of insects, including the important malathion-resistant strains and is effective at about one-third the dosage used for malathion. Full registration is expected by the end of the year. A second compound, (chlorpyrifos-methyl®), also shows promise as a protectant for peanuts. Its broad spectrum of insecticidal activity and low mammalian toxicity make it a promising insecticide for many uses. Registration is pending.

The technology of host plant resistance in peanuts for stored-product insects has not been researched. The idea of developing a peanut variety that would have built-in resistance to stored product insects should not be out of the realm of possibility. Somewhere in the large pool of germplasm of cultivated and wild peanuts there should be genes that would inhibit some of our stored product insects from feeding.

PANEL 3: Developing and Emerging Technologies for Peanut Quality and Marketing.
A. Brown, Chairman

Maturity Tests
E.J. Williams

Peanut maturity has been the subject of a considerable amount of research over the past few years. Probably no other subject relative to the peanut crosses so many discipline lines and has such a decided effect on crop quality, value, and economic return. Yet maturity has been subject to a considerable misunderstanding and some controversy.

The effect of maturity on the quality of individual pods and seeds is well documented in the literature. Problems arise, however, when we consider the quality in bulked pod or seed lots. Plants contain pods of all maturity stages anytime after pod development has begun. Often 30-40 percent of the crop will be less than a desired level of maturity at the time of harvest for optimum yield and grade. This phenomenon of indeterminancy is generally recognized but often disregarded in consideration of quality.

The advent of maturity classification of individual pods by color changes of the middle hull has made possible distributional studies of pod maturity. These studies have shown a great diversity to exist in distributional shape characteristics of the crop which impact quality. Distributional shapes are primarily dependent on environment and to some extent on genotype. Maturity distributions range in shape from those which are uniformally distributed (poor lot quality) to those which are normally distributed (potential for good lot quality). Distributions with multiple peaks (split crops) or other environmentally induced aberrations are frequently observed at the time of optimum harvest.

Quality considerations in regard to maturity have been normally based on the average maturity of given pod or seed lots. If it were not for such diversity in distributions, any of the indices which correlate with individual pod or seed maturity might be used to correlate with crop quality. Average maturities, however, may give erroneous results when applied to split crops.

Often much of what we think of as quality is really a reflection of environment on distributional shape. For example, we think of the effect a drought has on quality when a drought affects the shape of the maturity

distribution. What we identify as the effect of production area differences on quality is really a manifestation of the environment on distribution. Such measures of quality are likely to be confounded with differences in distribution.

While poorly shaped distributions do not account for all of the quality problems inherent in bulked lots, they are responsible for many of the problems in the industry. Seed size alone is not entirely an adequate means of separation for maturity because of variation of mautrity within size segregates.

We are here, however, to discuss the effect of new technologies and their meaning. What does this new maturity technology hold for growers, processors, and researchers in terms of quality? For growers it means understanding the effect certain production practices have had upon their crop quality and improving on those practices. Distortions in maturity distributions are often evident and identified with the application of certain treatments. Improving on the time in which to dig the crop is in the forefront of quality improvement. For the sheller and processor there is potential for an in-shell postharvest test for identification of substandard lots. Such lots could be diverted to alternative use or blended upward for improved overall quality.

In research, the use of pod maturity distributions probably has its greatest potential for greater understanding of the peanut. It means finding different intrepretations of research data which may have been confounded with the distribution of maturity. The effect of various chemical treatments such as application of herbicides or growth regulants are often not reflected in yields or grades, but are reflected in distributional shapes. Irrigation may be indexed to pod set rather than an arbritary growth period. Much of what we call area differences in quality are likely to be the confounding effect of environment on maturity distribution. Varieties or other research treatments may be dug each at their optimum time to reflect their true yield potential under a given growth environment, rather than digging based on an overall average of all treatments or digging based on a control. Such techniques in the past have penalized some treatments while giving advantages to others.

Such technology holds an unlimited approach for studies in reproductive physiology of the peanut plant; for shaping

distributions through various production practices to reflect greater quality; in studies of plant nutrition for maximizing the use of nutrients with respect to the stage of development of the pods; for establishing susceptibility thresholds for insect or disease invasion of pods with respect to their stages of development; and in computer modeling and simulation for prediction and furthering our understanding of growth processes.

In conclusion we challenge you to think about maturity in terms of the maturity distribution--for here lies the answers to many of our quality differences.

<u>Aflatoxin</u>
R.J. Cole

Aflatoxin is the foremost quality problem facing the peanut industry--production through processing and export. Constant vigilance by all segments has contributed to the notable record achieved by the industry to date. While appropriate emphasis on detection must be continued, major emphasis in the future should be on the development of prevention technologies.

Aflatoxin production by aspergillus microorganisms is known to occur during both production and storage. The crop years characterized by the greatest economic losses due to preharvest aflatoxin contamination had severe and prolonged late season drought stress. A significant amount of information on these environmental conditions required to induce contamination has been obtained, and future efforts should be directed toward developing valid preventive measures. These should include biological methods, nutritional (especially calcium), physical (deep-pegging varieties), chemical (fungicides), or genetic techniques.

The most promising biological methods are related to microbiological antagonism. A natural microbial antagonist apparently is not available under conditions of low water activity and elevated soil temperatures. These might be developed by artificial selection or genetic engineering techniques. Physical (deep-pegging) and nutritional studies with calcium are currently being evaluated. The least promising and least desirable method (use of fungicides) should receive some additional attention (i.e., slow-release chemicals).

The most desirable preharvest preventive technique would be to develop genetic resistance to stress-related aflatoxin contamination. The logical first step is to ascertain if any genetic resistance is present in

available peanut germplasm, and, if so, to incorporate the resistance into acceptable commercial varieties. If genetic resistance is not available in the population, more sophisticated studies involving genetic engineering should be conducted to incorporate resistance from related crops such as soybeans.

Aflatoxin contamination in peanuts during storage and the variables contributing to its occurrence were addressed by Mr. John Smith in the Panel 2 discussion. Improvements in conventional storage methods as well as development of new concepts in storage are needed. The concept of underground storage seems to offer real potential for alleviating the major contributing factor to aflatoxin contamination in storage, namely the condensation problem.

A significant amount of data, pre- and post harvest, has been developed on aflatoxin contamination in peanuts. Assimilation of this information into a mathematical model for the peanut would aid in evaluation of alternative technologies for elimination and identification of knowledge gaps needed to resolve this most important problem.

Plant Growth Regulators
R.L. Ory

Bioregulators are synthetic chemicals that alter the growth and development of crop plants when applied at very low rates. Newly developed compounds are screened for their ability to maximize yield, increase tolerance to stress, improve quality, flavor, and shelf-life of the commodity, or enhance the resistance to pathogen infection. A few bioregulators are structurally related to known plant growth hormones; however, the majority of compounds are not chemically similar. Bioregulators have been in commercial use for several years on many major world crops such as wheat, rice, and cotton, but their use in modifying peanut growth has not been exploited until recently.

Thus far, the approach taken has been to treat peanuts with various chemicals in the field and greenhouse, and analyze how the bioregulator has changed yield or some specific biochemical component of the peanut seed. Information from these studies indicate that certain bioregulators can influence accumulation of components important to peanut quality and/or yield. A major disadvantage of this approach, however, is that it is costly, both in the time needed for plant and seed growth and in the quantity of chemical necessary for adequate

testing. In addition, there are cost and technical limitations on the number of biochemical components that can be analyzed. An improved cooperative effort between growers, breeders, plant physiologists, and chemists is needed to establish the potential benefits of bioregulators.

The time-consuming, qualitative test systems could be replaced if more information was available on mechanisms of component accumulation and control. Key target sites could then be identified and bioregulators could be tailor-made to induce the desired response. Development of test systems to examine the effects of bioregulators on plant cell metabolism would also provide an effective means to screen and monitor changes in morphology and chemical composition prior to expensive field testing on peanuts.

By investigating the mode of action of bioregulators, a great deal will also be learned about plant growth and development. Does a bioregulator exert its effect by changing the composition or stability of the endogenous plant growth hormones or hormone receptors? Do bioregulators act by changing the properties of plant biomembranes? Can bioregulators directly affect the process of controlled plant gene expression? What is the effect of bioregulators on different genotypes grown under various environmental conditions? By answering questions such as these, we will be closer to quickly developing improved peanut varieties.

Finally, if bioregulators are to be used on plants we need to know how safe they are in the environment. Analysis of harvested plant tissue for residual amounts of bioregulators must be made. Also the following questions should be addressed: How will the commodity's use be affected if trace levels of bioregulators are present on harvested tissue? Are the chemicals safe for farmers to use? Do bioregulators persist in the soil and reach potentially phytotoxic levels after years of application? With cautious optimism the commercial potential for bioregulator use is great. Only with continued research in this area will the full potential be met.

Quality Control Technologies
W.A. Parker

Peanuts are bought and sold on the basis of their unique flavor. Manufacturers are dependent on quality control technology to ensure uniformity of their products. Generally, this technology is applied after the fact and serves to eliminate product outside defined parameters.

Presently, no rapid tests or battery of tests are available to provide information on the potential of a given lot of peanuts to have good roasted flavor and high product quality characteristics in the end product. Present grading procedures provide no information that can be consistently used to indicate raw or roast quality, even the familiar SMK (sound mature kernel) grade designation does not necessarily mean mature nor does it denote good edible quality. Research has indicated that gas chromatographic volatile "fingerprints" may provide an indication of flavor quality but equipment and interpretation are presently limited. Introduction and development of new technology is needed to provide a real evaluation of quality potential in the areas of blanchability, uniformity of roast, roast appearance, chemical composition, and storability. Environment-maturity-size-quality relationships and interactions need to be developed through use of microcomputers and software to provide significant predictive information to eliminate those peanut lots predisposed to quality defects. Some shelling technologies may be used to separate visible damage or color deviations associated with quality defects. Foreign material is an important factor in storage and packaging, and efforts to reduce foreign material in farmer's stock and shell stock need to be expanded through use of laser, x ray, and ultrasonic technology.

Compositional aspects of quality as influenced by maturity, stress, freeze damage, and chemical residues represent a quality control area for which technology is very limited. Apparent progress is being made on maturity (digging date) estimations, but peanuts will still be grouped into lots in which maturity-related compositional differences will be large. Maturity, however, cannot wholly be equated with acceptable chemical quality or sensory quality in end products.

The effects of storage on farmer's stock and shell stock quality must be carefully assessed and technology to ensure the maintenance of initial quality must be developed. Packaging relative to safe transport and storage of bulk lots represent areas of needed work due to the negative influence of prior cargoes such as fertilizers, seafood, fruit, smoke damage, etc., encountered in transport.

Quality control technologies are complicated by the fact that quality has a nebulous definition in that "quality"

is applied in various ways by all phases of the peanut industry. Before the type of technological needs just described can be developed and implemented for specific roast, chemical, and organoleptic quality, parameters must be defined. Size alone is not sufficient. Under the present system all processors and handlers can meet guidelines within the current quality framework, and the consumer can still reject the product.

TEAM 1: Peanut Production Efficiency in the Virginia/ North Carolina and Southeastern Production Areas

Major Researchable Problems Identified

Relative priority 1/	Problem No.	Statement of problem
H	1	Develop and evaluate peanut germplasm and cultivars superior to existing cultivars in disease and insect resistance, drought tolerance, early maturity, yield, and quality.
H	2	Develop improved procedures for soil and water management with emphasis on cost/benefit ratios and protection and conservation of natural resources, especially soil and water resources.
H	3	Develop needed data on crop protection with emphasis on programs that result in cost reductions in peanut production.
M	4	Continue research in crop management systems to integrate all production factors into a production system that enables the peanut producer to produce peanuts efficiently and economically.
M	5	Develop basic peanut physiology knowledge relating to biochemical and physiologial processes and responses to changing environmental factors.

1/ H = High; M = Medium; L = Low. Priorities are relative only within each team report.

Further Description of Researchable Problems

HIGH PRIORITY

Problem 1 - Develop and evaluate peanut germplasm and cultivars superior to existing cultivars in disease and insect resistance, drought tolerance, early maturity, yield, and quality.

Nature and importance

Production costs have increased rapidly during the past ten years and profits are diminishing. Most of the production costs involve pesticide controls for both disease and insect pests. Genetic material is available for developing cultivars with resistance to major diseases and insect pests. The development of resistant cultivars best remedy to reduce the necessity for pesticide usage and thereby reduce costs and the associated environmental hazards. Germplasm and cultivar development with emphasis on resistance to leafspots, southern stem rot, sclerotinia blight, black root rot, lesser cornstalk borer, and southern corn rootworm should be accelerated since control of these pests require major efforts by growers.

As rapidly as possible, breeders should emphasize development of early maturing and drought tolerant cultivars. Early maturing cultivars can escape early freezes and are exposed to pests for shorter growth periods thereby reducing production costs. Drought tolerant cultivars will enable producers in all production areas to reduce production costs and minimize annual yield fluctuations associated with adverse weather.

In all germplasm and cultivar development, yield and quality must be high priority items. Currently the two peanut cultivars (Florunner and Florigiant), producing 80 percent of the total U.S. production, are very susceptible to most disease and insect complexes and require intensive management and chemical applications to maintain high yields and quality.

HIGH PRIORITY

Problem 2 - Develop improved procedures for soil and water management with emphasis on cost/benefit ratios and protection and conservation of natural resources, especially soil and water resources.

Nature and importance

In the United States the public is concerned about the potential loss or contamination of our natural resources. Much of this concern is directed at the farmer in regard to current soil and water management practices. Research is needed to help the peanut farmer better utilize soil and water resources while reducing costs and increasing the efficiency of peanut production. High priority items include tillage, pest relationships in changing tillage programs, fertility balances, and soil microbial interactions.

Especially important in the water management area is irrigation scheduling in regard to the peanut's response to irrigation, especially fruit initiation and development. The efficiency and costs of water use and types of systems must be evaluated. Pest interactions under irrigated production must be evaluated.

HIGH PRIORITY

Problem 3 - Develop needed data on crop protection with emphasis on programs that result in cost reductions in peanut production.

Nature and importance

Crop protection in peanut production accounts for more than 50 percent of the annual production or operating costs. The lack of adequate pest management systems has results in the "insurance use" of pesticides to prevent any disease, insect, and weed problems. Pest management systems must be developed so that producers can pursue a prescription approach to crop protection. To accomplish this, it is necessary to establish the basic parameters of plant and pest response to environmental conditions. Economic threshold data are needed for all peanut pests. The development of such data for peanuts is lagging behind other crops because of a lack of funding support. Pest management cannot be efficient until economic thresholds for pests and pest complexes are developed.

Once economic threshold data are available for a pest, emphasis on forecasting and advisory technology must continue. This will help growers use control measures only when pest populations exceed economic thresholds. Biological controls are receiving widespread interest because they are considered environmentally safe, but such controls may not actually reduce production costs. However, scientists must continue the search for biological controls.

Remote sensing technology is available but is not currently being fully utilized to help in crop protection. Research on applications of remote sensing to peanut production should be accelerated. Uses include monitoring pest outbreaks and migration, and providing predictive and historical data.

MEDIUM PRIORITY

Problem 4 - Continue research in crop management systems to integrate all production factors into a production system that enables the peanut producer to produce peanuts efficiently and economically.

Nature and importance
Much of the research data is not completely integrated into production management programs but remains as bits and pieces of information that the individual peanut producer tries to incorporate into his production plan. Research into production management systems is necessary for the farmer to fully utilize available knowledge. A standard production model for peanuts is needed. Such a curve can then be manipulated by plugging in new agronomic practices or changing environmental conditions. Such information will provide an understanding of the interactions that occur as single inputs change. This will provide the producer with a total production package to optimize yield and quality with minimum inputs and costs. As a part of the total system, integrated pest managment must receive priority in order to develop a prescription approach to pest control. Intensive use of computer technology will be needed in managment systems research.

MEDIUM PRIORITY

PROBLEM 5 - Develop basic peanut physiology knowledge relating to biochemical and physiological processes and responses to changing environmental factors.

Nature and importance
Information is lacking regarding the basic physiological and biochemical processes in the peanut plant. This lack of information inhibits plant breeders', pathologists', entomologists', and agronomists' understanding of responses of the peanut plant to their research efforts. Detailed knowledge on reproductive efficiency in the peanut plant is critical to further improvements in other

areas of research. In addition, there is a need for a better understanding of the peanut's growth and development in response to temperature, moisture, minerals, etc. Researchers must have a detailed knowledge of the fundamental physiological processes affecting fruiting yield, quality, and the plant's responses to environment and pests.

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TEAM 2: Peanut Production Efficiency in the Southwestern Production Area

Major Researchable Problems Identified

Relative Priority[1/]	Problem No.	Statement of Problem
H	1	Improve water management and water use efficiency.
H	2	Breed peanuts with increased genetic potential for profitable production in the southwest.
H	3	Develop integrated systems for managing peanut plant pests.
M	4	Devise management systems to maximize peanut production efficiency.
M	5	Improve aflatoxin monitoring, prevention and decontamination techniques.
M	6	Define fundamental plant processes affecting yield and response to pests.
L	7	Identify beneficial organisms and develop procedures for increasing field populations.
M	8	Improve methods for assessing and enhancing seed and product quality.

1/ H = High; M = Medium; L = Low.
Priorities are relative only within each team report.

Further Description of Researchable Problems

HIGH PRIORITY

Problem 1 - Improve water management and water use efficiency.

Nature and importance
Research is needed on the utilization of water by the peanut plant. It is important that peanut growers who

have limited amounts of irrigation water know which stage of growth is most effective in utilizing a limited amount of water for maximum return on investment in pumping. New and different application techniques should be investigated to determine if there are less expensive ways to irrigate peanuts. Water quality should also be evaluated.

HIGH PRIORITY

Problem 2 - Breed peanuts with increased genetic potential for profitable production in the southwest.

Nature and importance

Research is needed in the area of breeding, testing, genetics, and cytogenetics to develop varieties for efficient production at minimal risks having high yield potential, high product quality, and consumer acceptance. There is a great need to evaluate the large collection of germplasm available.

HIGH PRIORITY

Problem 3 - Develop integrated systems for managing peanut plant pests.

Nature and importance

Pest management strategies and systems based on judicious use of chemicals and non-chemical practices which preserve the beneficial organisms must be identified, developed, and implemented.

MEDIUM PRIORITY

Problem 4 - Devise management systems to maximize peanut production efficiency.

Nature and importance

Research is needed to assist southwest peanut producers in optimizing profits and minimizing inputs so that time and money can be saved. This includes: developing tillage methods, crop rotations, cultural practices, and pesticide applications that maximize production efficiency.

MEDIUM PRIORITY

Problem 5 - Improve aflatoxin monitoring, prevention, and decontamination techniques.

Nature and importance
Soil conditions which favor the survival and activity of *Aspergillus* flavus and *A. parasiticus* must be determined in order to develop controls for reducing activity. Screening procedures for identifying peanut strains that resist invasion by *Aspergillus* are needed, as are production, curing, harvest, transport, and storage practices which minimize aflatoxin contamination. Improved, rapid, simple, and accurate aflatoxin detection methods and improved sorting equipment are important to the identification and removal of contaminated peanuts from the marketing system. Accepted detoxification procedures could reduce current market losses.

MEDIUM PRIORITY

Problem 6 - Define fundamental plant processes affecting yield, quality, and response to pests.

Nature and importance
An enhanced knowledge of the identity and relative importance of those basic plant components and processes that quantitatively contribute to yield, quality, and pest resistance is essential to continued improvement in cost efficiency of production.

LOW PRIORITY

Problem 7 - Identify beneficial organisms and develop procedures for increasing field populations.

Nature and importance
Numerous beneficial organisms have been identified in peanut fields. Additional research will result in the discovery of more information about the diversity of beneficial organisms and increased knowledge about their ecology. This information is needed to develop an efficient management strategy that will optimize the role of beneficial organisms and result in the increased production of high quality peanuts.

MEDIUM PRIORITY

Problem 8 - Improve methods for assessing and enhancing seed and product quality.

Nature and importance

Improved seed and product quality is essential if peanuts are to remain competitive in domestic and foreign markets. Research needs and objectives include the following: develop methods for detecting and identifying quality factors in peanuts; develop methods for prevention of factors that cause off flavor and poor quality; develop methods for reclaiming because of poor quality peanuts; develop methods for early detection of freeze damage; characterize the environmental conditions that produce freeze damage in peanut seed and storage at harvest time; and completely redefine the grading system so that quality is reflected in the grade.

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TEAM 3: Harvesting, Handling, and Marketing Efficiency

Major Researchable Problems Identified

Relative priority[1/]	Problem No.	Statement of problem
H	1	Develop sensors (transducers) that are compatible with microprocessors and minicomputers for use in controlling harvesting, curing, and drying equipment.
H	2	Develop a farmer stock peanut grading system that accurately reflects peanut quality.
H	3	Develop models that can be used to simulate digging, curing, drying, and shelling to maintain or improve quality of peanuts.
H	4	Develop new uses and markets for peanuts and peanut by-products.
M	5	Develop innovative drying and curing systems.
M	6	Develop technology for maintaining peanut pod and kernel quality during torage.
L	7	Develop and integrate alternate energy sources that are reliable, economical, and easily managed.

1/ H = High; M = Medium; L = Low. Priorities are relative only within each team report.

Further Description of Researchable Problems

HIGH PRIORITY

Problem 1 - Develop sensors (transducers) that are compatible with microprocessors and microcomputers for use in controlling harvesting, curing, and drying equiment.

Nature and importance
Developments in microcomputers and microprocessors have made this technology attractive for control of harvesting and drying processes and equipment. However, sensors for detecting such variables as peanut moisture content, air flow rate, air relative humidity and product flow rates continuously are not available. Development of these sensors are essential in order to provide continuous feedback to the microprocessor so that harvesting and drying equipment can be controlled to minimize operation costs, minimize pod and kernel damage and thereby improve ultimate peanut kernel quality. Successful completion of this research will result in:

- o Bin or wagon drying systems that produce kernels at optimum moisture content for storage and reduce over-drying problems encountered in current systems.
- o Reduce energy costs for drying when compared to current drying systems.
- o Automatic control of combine cylinder speed, reel speed, fan speed and ground speed to minimize peanut loss and damage during harvest.

HIGH PRIORITY

Problem 2 - Develop a farmer stock peanut grading system that accurately reflects peanut quality.

Nature and importance
Current grading standards do not reflect quality of final market use of peanuts and therefore, do not accurately define value of farmer stock peanuts. Because of inability to accurately define effects of foreign material, sound meats and damage, it is estimated that value of specific lots of farmers stock peanuts may be either undervalued or overvalued by as much as $40 per ton. The net effect is to penalize producers that do a good job of controlling quality of their crop. Also processors cannot rely on the grading system to predict shelling and roasting characteristics of peanuts that are purchased. Research is needed to develop criteria and

methods for measuring those properties of farmers stock peanuts that ultimately determine the quality attributes in the marketplace. When the research is complete farmers will be able to adjust their management programs to produce higher quality products and thereby improve their economic return. This research will also result in more favorable treatment of U.S. peanuts in the international market and higher quality products for the U.S. consumer.

HIGH PRIORITY

Problem 3 - Develop simulation models that can be used in digging, curing, drying, and shelling to maintain or improve quality of peanuts.

Nature and importance
Research is needed to develop simulation models and algorithms to improve peanut quality and minimize energy inputs. Development of maturity models that can predict optimum digging times as a function of environmental conditions will minimize harvest of immature pods and reduce quality problems encountered in drying and storage caused by high moisture and insect infestations. Development of drying and curing models for both window and bin drying is needed for each of the three peanut producing regions to allow producers to make decisions on the combining time that will optimize kernel quality and drying costs. Likewise, simulation of specific operations in the peanut shelling plant will lead to economic optimization of shelling plants and subsequent automation through the use of innovative robotic technologies. This modeling research will result in development of algorithms that are essential in the interfacing of microcomputers to drying and shelling equipment and processes.

HIGH PRIORITY

Problem 4 - Develop new uses and markets for peanuts and peanut byproducts.

Nature and importance
Development of new uses and markets for peanuts and peanut byproducts will result in reduced surpluses and improved economic conditions to U.S. farmers. Therefore, research is needed to:

A. Develop new uses and markets for peanuts. Regardless of whether price supports are continued, the growing diet consciousness of American consumers may lead to a

flattening or reversal of per capita peanut consumption. A program should be started to:

- Look for new food, industrial, and possibly feed uses of peanuts. This program might beneficially use different varieties than those optimum for traditional uses.
- Demonstrate these uses by development of prototype products which are brought to the attention of potential processors and/or users.

B. Develop an accepted process for detoxification of aflatoxin in peanut meals. Despite years of research and concern, a process for salvaging aflatoxin-contaminated peanut meal for feed use, acceptable to the Food and Drug Administration, does not yet exist. Several options exist, including ammoniation, solvent extraction, and detoxification by oxidizing agents. The process might be added to each peanut oil mill, or meal, known to be contaminated, might be collected for central processing. Emphasis should be placed on the follow through to get at least one economical procedure approved.

C. Enhance economic value of peanut hulls. Any increase in the market value of peanut hulls would improve the profitability of growing and processing peanuts. Peanut hulls have been used for various limited applications, such as cat litter, pressed imitation firelogs, furfural feed material, and compressed air polishing. Also, hulls have been included in ruminant feeds as fiber sources and bulking agents, and have been burned as fuel. Research needs to be initiated to find uses for large quantities of peanut hulls that will command higher prices than boiler fuel.

MEDIUM PRIORITY

Problem 5 - Develop innovative drying and curing systems.

Nature and importance
Current drying practices are the result of recommendations developed approximately two decades ago. Research since that time indicates other drying processes may tolerate higher drying temperatures during cyclic drying and maintain kernel quality. Likewise, drying conditions for peanuts used in the edible market for oil and for seed are likely different. Totally new processes like microwave-vaccuum drying may have potential for solving some quality

problems while improving dryer energy efficiency. We still do not know the effects on quality of different drying conditions when peanuts are subjected to long-term storage. Therefore, research is needed to investigate and quantify effects of drying and curing conditions on quality during long-term storage of peanuts used for food, oil, or seed; to develop methods for modification of moisture diffusion properties; to develop methods of improving dryer efficiency through energy reclamation; and to develop new processes such as microwave-vacuum drying.

MEDIUM PRIORITY

Problem 6 - Develop technology for maintaining peanut pod and kernel quality during storage.

Nature and importance

Research is needed to: determine the effects of methyl bromide and other pesticides on organoleptic properties and other quality attributes of stored peanuts; determine the effects of air flow rates and storage temperatures on quality changes during long-term storage; define storage environmental conditions to maintain seed peanut quality; and develop systems for removal of immature peanut pods prior to storage successful completion of the research will result in reduced stored insect problems and increased quality of peanut products to the consumer and for export.

LOW PRIORITY

Problem 7 - Develop and integrate alternate energy sources that are reliable, economical, and easily managed.

Nature and importance

With increasing energy costs and potential for future supply interruptions due to lack of reliability of foreign oil producing countries, it is essential that the United States continue development of alternate energy sources for use in the peanut industry. Solar and biomass energy sources offer the greatest potential for providing economic systems that are reliable and require acceptable management levels. Development of technologies for using peanut oil and peanut hulls will also offer the potential for expanding the market for peanut products.

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TEAM 4: Quality and Marketing Goals

Major Researchable Problems Identified

Relative priority[1/]	Problem No.	Statement of problem
H	1	Develop objective test methods to measure quality, including detection of aflatoxin, of farmer's stock and shelled stock peanuts.
H	2	Eliminate and/or reduce foreign materials in shelled peanuts, possibly at farmer's stock level.
M	3	Establish nature and extent of the relationship between quality factors and existing grading factors for peanut varieties.
M	4	Devise quality test procedures for use by breeders in developing and evaluating new varieties.
M	5	Develop and utilize an objective, reliable method that identifies peanut maturity for farmer's stock peanuts and determine relationship to shelled stock of various grades and varieties.
M	6	Identify and maintain quality during storage of farmer's stock and shelled peanuts.
L	7	Identify areas of possible market opportunities for selective consumer use.
L	8	Develop data on consumer attitude and image of peanut products including peanut butter.
L	9	Develop data and position papers on critical, high-risk subjects for industry response to public or market issues when required, and for promotion, if to industry advantage.

1/ H = High; M = Medium; L = Low. Priorities are relative only within each team report.

Further Description of Researchable Problems

HIGH PRIORITY

Problem 1 - Develop objective test methods to measure quality, including detection of aflatoxin, of farmer's stock and shelled stock peanuts.

Nature and importance

With the exception of aflatoxin, current USDA grade procedures cover only moisture content and physical parameters or characteristics of farmer's stock and shelled peanuts. None of the physical grade factors, including size and splits, can be fully equated to edible quality and such critical characteristics as roast flavor and peanut flavor intensity. Current grading procedures also fail to provide some indication of heat damage.

Objective test methods are needed to determine quality factors such as flavor--desirable and undesirable, freeze damage, heat damage, brown spots, estimated shelf life, roast uniformity, and maturity in farmer's stock peanuts and shelled peanuts. Once developed and proven, these objective tests should be used as part of the grading procedures to establish grade quality. Availability of information on quality factors will be most important to the competitive position of U.S. peanuts in future markets, export and domestic.

HIGH PRIORITY

Problem 2 - Eliminate and/or reduce foreign materials in shelled peanuts, possibly at farmer's stock level.

Nature and importance

Foreign material complaints from consumers (retail, manufacturers, and blanchers) account for 50 percent of all complaints from peanut processing and in some instances account for nearly two-thirds of all complaints. Total liability claims are reported to be several thousand dollars per month for some processors. Improved efficiency in removing foreign materials at all points in the systemand expression on the grade certificate as count (number of pieces) per 100 pounds of shelled peanuts should greatly reduce adverse economic impact of this quality factor.

MEDIUM PRIORITY

Problem 3 - Establish nature and extent of the relationship between quality factors and existing grading factors for peanut varieties.

Nature and importance
Information on the relationship between current grading factors and quality characteristics is lacking for most varities. Verifiable data on the relationship between screen size and characteristics such as flavor, shelf life, and roasting quality for the major varieties from different environments and levels of maturity are particularly important to the marketing and utilization of peanuts.

MEDIUM PRIORITY

Problem 4 - Devise quality test procedures for use by breeders in developing and evaluating new varieties.

Nature and importance
Most of the current variety screening tests are either subjective or relate to size and performance in shelling and blanching. Rapid, objective screening procedures for all pertinent characteristics, particularly flavor, maturity, and roasting quality are needed to enable breeders to sustain and improve the quality of U.S. peanuts.

MEDIUM PRIORITY

Problem 5 - Develop and utilize an objective, reliable method that identifies peanut maturity for farmer's stock peanuts, and determine relationship to shelled stock of various grades and varieties.

Nature and importance
Peanut maturity is usually critical to obtaining maximum quality characteristics in harvested nuts such as oil content, iodine value, roast quality, peanut flavor, and shelf life in addition to maximum yield. A reliable, inexpensive, portable method for maturity is required for field application, buying station, and the segregation of farmer's stock storage. Availability and utilization of such a method by all segments of the peanut industry could vastly improve the overall quality of U.S. peanuts and enhance marketability--domestic and export.

MEDIUM PRIORITY

Problem 6 - Identify and maintain quality during storage of farmer's stock and shelled peanuts.

Nature and importance

Environmental conditions of storage of farmer's stock and shelled peanuts could greatly influence the rate of physiological changes and physical defects due to insects and microorganisms which, in turn, affect end use quality and safety. Changes in enzyme activity, flavor, roast intensity, shelf life, and the ability to meet sanitary and safety regulations could all be affected. A better understanding of the changes which occur under different storage conditions could provide the basis for development of test procedures that are indicative of changes or the lack thereof in stored peanuts and/or the conditions under which they are stored.

LOW PRIORITY

Problem 7 - Identify areas of possible market opportunities for selective consumer use.

Nature and importance

Utilization of peanuts could be expanded if appropriate information on market opportunities were developed. Some of the potential areas for additional selective use that should be explored are as follows: uniform kernel; improved nutrition; low fat (calorie) peanut with all natural oil; small uniform (mature) kernel size for confectionary use; peanut flour (toasted and extracted); and partially defatted peanuts.

LOW PRIORITY

Problem 8 - Develop data on consumer attitude and image of peanut products including peanut butter.

Nature and importance

Little or no industry data are available to define what the present day consumer prefers, or does not want, regarding use of and attitude towards existing peanut products (in total).

LOW PRIORITY

Problem 9 - Develop data and position papers on critical, high-risk subjects for industry response to public or market issues when required, and for promotion, if to industry advantage.

Nature and importance

Timely availability of a unified industry position on critical public or market issues would greatly enhance the image and credibility of the peanut industry. Potential and current subjects (problems) that require data to formulate policy for industry response for which may not be available include: pesticide residues (already requested for export); methyl bromide residue and safety; mycotoxins--freedom of and not only related to aflatoxin; long chain fatty acids and effect on platelet in blood vessels; nutrition of peanut butter; absences of pathogens, salmonella, etc.; and foreign materials.

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J.C. Takash	Snack-Master, Albany, GA
C.T. Young	North Carolina State Univ, Raleigh, NC
G.C. Zekert	Planters Peanuts, Suffolk, VA

TEAM 5: Quality and Marketing Goals

Major Researchable Problems Identified

Relative priority[1/]	Problem No.	Statement of problem
H	1	Revise grading system from the farmer's stock level on through the marketing chain.
H	2	Develop additional relevant data on specific quality factors--maturity, aflatoxin, foreign material, freeze damage, off-flavors.
H	3	Establish a peanut product market profile for use by the industry.
L	4	Develop peanut cultivars with a higher oil content

1/ H = High; M = Medium; L = Low. Priorities are relative only within each team report.

Further Description of Researchable Problems

HIGH PRIORITY

Problem 1 - Revise grading system from the farmer's stock level on through the marketing chain.

Nature and importance

The present grading system does not accurately reflect the quality factors of a lot of peanuts. The end user must know the quality of the peanuts received from the processor so as to deliver the best possible peanut product to the consumer. The current grading system should be revised from the farmer's stock level on through the marketing chain. Research is needed to develop a method of determining maturity; develop a rapid, simple, and accurate method of detecting aflatoxin at the buying station; develop an accurate method of identifying freeze damage at the buying station; and evaluate the present grading equipment including the pneumatic sampler.

HIGH PRIORITY

Problem 2 - Develop additional relevant data on specific quality factors--maturity, aflatoxin, foreign material, freeze damage, and off-flavors.

Nature and importance
Maturity, aflatoxin, foreign material, freeze damage, and off flavors are all major quality problems affecting the industry. Improving the grading system as suggested above will correct some of these problems. Expanded research is needed as follows:

Maturity: Educate the growers on the "hull-scrape" method of determining optimum digging time; and develop methods to detect and separate immature peanuts in farmer's stock.

Aflatoxin: Develop instrumental methods of aflatoxin analysis.

Foreign material: Reduction of foreign material at the farm level; reduction of foreign material in farmer's stock stored peanuts; and more accurate detection of foreign material in shelled.

Freeze damage: Determine what role freeze damaged peanuts play in off flavors; and use of plastic to prevent freeze damage.

HIGH PRIORITY

Problem 3 - Establish a peanut product market profile for use by the industry.

Nature and importance
Adequate market research on demographics on pertinent acceptance and qualification factors, and on new product opportunities is essential to a successful marketing program. The industry does not have and is in need of a peanut product profile.

LOW PRIORITY

Problem 4 - Develop peanut cultivars with higher oil content.

Nature and importance

There is a growing demand for peanut oil by restaurants, bakeries, etc. Peanut oil is not now price competitive with other vegetable oils. The development of a peanut with a high oil content (above 65 percent) that produces a high per acre yield at a low production costs would improve the competitive position of peanut oil in export and domestic markets.

Team chairman: Mary Webb, Texas Peanut Producers Board, Gorman, TX

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APPENDIX II: WORKSHOP AGENDA

USDA-ARS PEANUT WORKSHOP
July 16-17, 1984
Municipal Auditorium, Mobile, AL

Monday morning, July 16, Room 28 (Phil Miller, Presiding)

8:00 Workshop Objectives and Procedures...Phil Miller

8:15 U.S. Peanut Industry-Current Situation & Outlook ...Duane Hacklander

9:00 Developing and Emerging Technologies for Peanut Production and Management:

Panel No. 1 — D. M. Porter, Chairman; D. J. Banks, Recorder

Breeding and Genetics ....J. C. Wynne
Production & Management Systems......R. J. Henning
Pathology ....D. M. Porter
Entomology ....J. W. Smith
Weeds ....C. W. Swann

Discussion

10:30 Coffee Break

10:45 Developing and Emerging Technologies for Harvesting, Curing, Shelling, and Storage

Panel No. 2 — J. L. Butler, Chairman; M. L. Wylie, Recorder

Harvesting and Curing ....J. L. Butler
Drying ....J. M. Troeger
Shelling ....J. I. Davidson
Storage ....J. S. Smith
Insect Control in Stored Peanuts ..L. M. Redlinger

Discussion

12 Noon - Lunch

Monday Afternoon, July 16, Room 28 (Wilda Martinez, Presiding)

1:30 Developing and Emerging Technologies for Quality and Marketing

Panel No. 3 A. L. Brown, Chairman
T. H. Sanders, Recorder

Maturity Tests ....E. J. Williams
Aflatoxin ....R. J. Cole
Plant Growth Regulators ....R. L. Ory
Quality ....W. A. Parker
Discussion

3:00 Coffee Break

3:15 Individual Problem Area Team Meetings

Team 1. Peanut Production Efficiency in the Virginia/North Carolina and Southeastern Production Areas.
Team Chairman: G. A. Sullivan (Room G)

Team 2. Peanut Production Efficiency in Southwestern Production Areas.
Team Chairman: L. D. Tripp (Room J)

Team 3. Harvesting, Handling, and Marketing Efficiency.
Team Chairman: B. L. Clary (Room H)

Team 4. Quality and Marketing Goals.
Team Chairman: W. A. Parker (Room K)

Team 5. Quality and Marketing Goals.
Team Chairman: Mary Webb (Room L)

Tuesday morning, July 17, Room 28 (Ralph Nave, Presiding)

8:00 Preliminary Oral Team Reports - Team Chairmen

Audience Response--identification of gaps, duplications, and needed interactions among teams.

10:00 Coffee Break

10:30 Closing Comments - Wilda Martinez

11:00 Final Preparation of Reports and Priority Setting.

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